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July 31, 2020

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Quarterly Progress Report for the Period of April 1 – June 30, 2020, "Produced Water Management Through Geologic Homogenization, Conditioning, and Reuse"; Contract No. G-051-010

Attached please find the Energy & Environmental Research Center (EERC) Quarterly Progress Report for the subject project. If you have any questions, please contact me by phone at (701) 777-5421 or by e-mail at kglazewski@undeerc.org.

Sincerely,

DocuSigned by:
DFF46D8431F8412...
Kyle A. Glazewski
Senior Analyst

KAG/kal

Attachment

c/att: Michael Holmes, Lignite Energy Council
Brent Brannan, North Dakota Industrial Commission (NDIC) Department of Mineral Resources, Oil and Gas Division

c: Paul Arnason, EERC

# PRODUCED WATER MANAGEMENT THROUGH GEOLOGIC HOMOGENIZATION, CONDITIONING, AND REUSE

Quarterly Technical Progress Report

*(for the period April 1 – June 30, 2020)*

*Prepared for:*

Karlene Fine

North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
State Capitol, 14th Floor
Bismarck, ND 58505-0840

Contract No. G-051-010

*Prepared by:*

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July 2020

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# SUBTASK 3.2 – PRODUCED WATER MANAGEMENT THROUGH GEOLOGIC HOMOGENIZATION, CONDITIONING, AND REUSE

## EXECUTIVE SUMMARY

The Energy & Environmental Research Center (EERC), in partnership with Nuverra Environmental Solutions (Nuverra) and the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP), will assess the techno-economic viability of using the Inyan Kara Formation as a geologic solution for produced water treatment and recycling. This Stage I effort will investigate this new approach, herein referred to as geologic homogenization, conditioning, and reuse (GHCR), to managing produced water while simultaneously addressing oil and gas industry challenges related to the management of increasing volumes of produced water and resulting pressurization of geologic formation use for saltwater disposal. GHCR takes advantage of natural processes occurring in the subsurface (such as dilution, mixing, and filtering) that will improve produced water quality prior to extraction for subsequent reuse. The GHCR concept represents a nontraditional and potentially transformational approach to produced water management. The benefits of the concept include using existing infrastructure and industry practices, enabling large-volume subsurface storage of produced water, displacing freshwater demand within the industry, and reducing the magnitude and rate of pressurization of the target formation.

This progress report represents an update of the Subtask 3.2 – Produced Water Management Through Geologic Homogenization, Conditioning, and Reuse activities from April 1 through June 30, 2020.

A subtask kickoff meeting was held with the U.S. Department of Energy (DOE) via WebEx on April 13, 2020.

The design and construction was completed for laboratory-scale columns that will be used to replicate the Inyan Kara Formation and evaluate the effectiveness of the GHCR concept. Water was collected from the Brine Extraction and Storage Test (BEST) E-1 well that constitutes Bakken produced water that has migrated through and has been subsequently extracted from the Inyan Kara Formation, thus providing field data to evaluate the impact on produced water flowing through the Inyan Kara Formation.

The EERC holds an unwavering commitment to the health and well-being of its employees, partners and clients, and our global community. As such, precautionary measures have been implemented in response to COVID-19. Staff continue to carry out project-related activities remotely, and personnel supporting essential on-site laboratory and testing activities are proceeding under firm safety guidelines. Travel has been minimized, and protective measures are being undertaken for those who are required to travel. At this time, work conducted by EERC employees is anticipated to progress with minimal disruption. Challenges posed by economic variability will be met with open discussion between the EERC, the DOE Project Manager, and other partners to identify solutions. The EERC is monitoring developments across the nation and abroad to minimize risks, achieve project goals, and ensure the success of our partners and clients.

# SUBTASK 3.2 – PRODUCED WATER MANAGEMENT THROUGH GEOLOGIC HOMOGENIZATION, CONDITIONING, AND REUSE

## ACCOMPLISHMENTS

### Major Goals of the Project

In this subtask, the Energy & Environmental Research Center (EERC), under Cooperative Agreement No. DE-FE-0024233 with the U.S. Department of Energy (DOE) and in partnership with Nuverra Environmental Solutions (Nuverra) and the North Dakota Industrial Commission (NDIC) Oil and Gas Research Program (OGRP), will assess the techno-economic viability of using the Inyan Kara Formation as a geologic solution for produced water treatment and recycling, with the added benefit of providing a potential solution to pressurization of the Inyan Kara Formation in North Dakota. This subtask update is for April 1 through June 30, 2020.

This Stage I effort will provide data on current methods for produced water treatment and recycling and assess the commercial viability of geologic homogenization, conditioning, and reuse (GHCR) for produced water management. In addition to developing and compiling data regarding produced water management methods, the subtask investigates a new approach to managing produced water while simultaneously addressing oil and gas industry challenges related to the management of increasing volumes of produced water and pressure increases in the Inyan Kara Formation. If successful, the GHCR concept offers an attractive technological and economic solution for managing produced water through 1) incorporating existing industry practices and infrastructure to homogenize and condition produced waters for subsequent treatment and/or reuse; 2) enabling large-volume storage and a virtually limitless supply of consistent-quality produced water for subsequent beneficial reuse, displacing freshwater demand and thereby providing assurance of future water supply; and 3) reducing the net volume of saltwater disposal (SWD), thus reducing the magnitude and rate of pressurization of the target disposal formation, extending the life of SWD wells, and reducing oil and gas development costs associated with Inyan Kara pressurization.

The goal of the subtask is to assess the techno-economic viability of using the Inyan Kara Formation as a geologic solution for produced water treatment and recycling. Specific research objectives related to this goal are as follows:

- Evaluate produced water management methods, trends, and costs; capacity of water supply and disposal facilities; economic, regulatory, and technological considerations for water recycling and reuse applications relevant to Bakken produced water management.

- Aim to replicate the interaction between Bakken produced water and the Inyan Kara Formation through laboratory experiments.

- Simulate the performance of the GHCR concept using geologic and geochemical models.

- Assess the techno-economic viability of the GHCR concept, including the relevant technical, economic, regulatory, financial, scientific, and technological considerations affecting potential commercial adoption of GHCR.

**Accomplishments under These Goals (for the reporting period)**

A subtask kickoff meeting was held with DOE via WebEx on April 13, 2020.

Activity 1.0 work is in progress to assemble data and information for the Produced Water Quality Assessment report, that is due October 1, 2020 [Deliverable (D) 4 and Milestone (M) 3]. Data collection from publicly available sites such as NDIC Department of Mineral Resources, Frac Focus, and North Dakota State Water Commission is complete and analysis of these data is being incorporated into the report. Data sets collected include information on produced water volumes, water chemistries, hydraulic fracture fluid makeup, and freshwater allocations. These data sets will provide insight into industry water management practices and trends, providing the foundation for evaluating the techno-economic viability of the project's GHCR concept.

Activity 2.0 completed the design and construction of laboratory-scale columns that will be used to replicate the Inyan Kara Formation and evaluate the effectiveness of the GHCR concept.. Quartz sand with various grain sizes obtained to replicate similar Inyan Kara grain distribution and porosity was purchased, satisfying M1. The quartz sand is being used because weathering of the Inyan Kara material from the outcrop in South Dakota may impact the physical properties of the material. The purchased quartz sand offers better control for matching porosity and permeabilities, as determined from Inyan Kara core analysis.

A field sample was collected and analyzed from the Johnsons Corner SWD extraction well. This water constitutes produced water that has migrated through and has been subsequently extracted from the Inyan Kara Formation.

For Activity 3.0, a meeting was scheduled with the EERC modeling team and laboratory/field team to develop and implement a data collection and analysis plan for Activity 2.0. This meeting will ensure pertinent data are collected from the laboratory study and field site that can be used in geologic modeling and simulation efforts.

State regulations surrounding produced water management are being assessed for North Dakota and compared to other oil producing states to understand potential challenges and opportunities for produced water recycling in North Dakota under Activity 4.0.

**Plan for the Next Reporting Period to Accomplish the Goals**

The project team will work with operators and Bakken Production Optimization Program (BPOP) partners, acting as a technical advisory group, to conduct an assessment characterizing the variability and distribution of Bakken produced water quality in North Dakota. The assessment will also seek to gain industry insight into the barriers for recycling/reuse of produced water.

The laboratory column study will be started by packing the column with quartz sand to replicate physical properties of the Inyan Kara Formation. Inyan Kara Formation water, with native water chemistry not impacted by saltwater disposal, will be added to the column to complete the setup of the laboratory columns. Synthetic Inyan Kara water will be created to replicate the native Inyan Kara Formation water chemistry for use in the event native formation water cannot be acquired from a water production well. Upon filling the column with quartz sand and native Inyan Kara chemistry water, Bakken produced water collected from the field will be injected to begin the testing in July 2020.

Geologic and geochemical modeling will be initiated using results of data compiled in Activities 2 and 3.

Techno-economic viability work will be initiated.

## CHANGES/PROBLEMS

The EERC is operational and open for business. Personnel that are not essential for on-site operations have transitioned to working from home. Essential project, laboratory, and field-based activities are proceeding with the incorporation of the Centers for Disease Control and Prevention (CDC), the State of North Dakota, and the University of North Dakota guidelines associated with COVID-19, and mitigation measures have been implemented.

In collaboration with project partners, the EERC is continually assessing potential impacts to project activities resulting from COVID-19 and/or the U.S. economic situation. At the time of reporting there has not been a substantial impact to the project. In the event that any potential impacts to reporting, scope of work, schedule or cost are identified, they will be discussed and addressed in cooperation with the DOE Project Manager.

### Changes in Approach and Reasons for Change

A revised engagement strategy was developed to engage Bakken producers regarding produced water management practices in response to widespread travel restrictions and social distancing guidelines.